Woman C.P.A.

Volume 35 | Issue 4 Article 3

10-1973

Electronic Data Processing: Economic Trends in the Computer Industry

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Economic Trends in the Computer Industry

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Forecasts in any industry are usually hazardous, and in one which changes as rapidly as the computer industry, this is especially true. A short item in the "Rumors and Raw Data" section of the June 1, 1971 copy of *Datamation* captured the problems of making such an analysis when it reported:

> A midwest memory manufacturer who asked employees for suggestions to help the planning committee anticipate tomorrow's technological needs received this interesting piece of advice: Subscribe to all the science fiction magazines.

It would be exciting and daring to predict the introduction of revolutionary and previously unknown techniques and equipment which will dramatically change everyone's lives. Yet while it is apparent that the developments in the computer and information handling industry will impact everyone, the changes are essentially evolutionary. They follow a logical, although highly accelerated, path of development which can be analyzed to identify the pattern of growth. Thus one can gain insight into the trends which have developed and will influence the future.

Sheer technical change has occurred at a nearly incomprehensible pace. Internal memory has increased in capacity and speed, and changed in organization; machine recognizable external storage has changed form from cards to tape to disk to magnetic ink characters to even the printed page and the spoken word; programming techniques and languages have proliferated and become increasingly problem-oriented. All of these developments have produced an atmosphere of excitement and new challenge which, in the rush to absorb the new technology, has sometimes obscured the larger question of the relationship of the computer and/or data processing industry to the rest of society.

Despite its ever-changing technology, the industry must bow to the same rules of judgment and evaluation which govern any other segment of a society – it must produce services which are *useful* to others and it must produce those services less expensively than any other alternative. If this criteria is not met then there will be no demand, and therefore support, for the continued existence or growth of the industry.

The principle involved is the rather straightforward economic rule that the less expensive alternative will be substituted for the more expensive one. Computers are not exotic play toys (although sometimes that temptation exists) – they are instead a production tool whose output is usable information. Their justification for being is that they can produce the information that is needed less expensively than any other technique. Their justification does *not* lie in processing volumes of unnecessary data however efficiently that is done or in sophisticated techniques that are so expensive that the costs involved far outweigh the benefits. There has been increasing criticism in the last few years of the failure to properly control and justify the costs of computer activity. And one fairly sure prediction for the future is that the concern for economic justification and more searching cost-benefit analyses of computer facilities and activities will be more important than ever. This will be the result of several factors: the current economic situation; the increasing expenditures for EDP activities; the failure of many proposed projects to provide the widely promised benefits; and, finally, the recognition that computer facilities (hardware and staff) must compete for scarce economic resources just like any other alternative production facility.

This is not intended in any way to suggest that cost advantages have not existed in the past nor that the potential does not exist for great growth in the future. The dramatic increase in the number of computers from an estimated 5000 in the United States in 1960 to 52,000 in 1970 with value in excess of $20 billion is evidence enough that quite the contrary is true. We have moved from a situation in which only the largest firms could justify a computer to today's market when the range of computer capability has been expanded to the point where even the smallest firm can have a computer facility in the form of a "mine" computer or time-sharing. A recent study suggests a potential domestic market for mine's of over 500,000 units.

All of this has been made possible through technological developments which have improved cost-performance ratios substantially. Continued technological improvements (for example, new approaches to storage such as virtual memory and thin film, development of integrated circuitry, and new techniques for data collection) are expected to increase speeds by a factor of five while at the same time cutting costs in 1975 to

about 1/2 to 1/8 of the levels in 1970. If those who are active in the computer industry can succeed in organizing their operations and skills in such a way as to make it possible for customers (i.e., the rest of the firm or institution of which they are a part) to benefit from these technological developments they will succeed in creating a continuing demand for their services. This calls for a deliberate effort to continually evaluate the choice of alternative techniques within the computer installation for the best cost-benefit ratio possible.

In the "early" history of computers – way back in the ancient times of the 1950's – hardware costs were the major part of total expenditures for computer activities. At that time 80¢ of every dollar spent went for hardware. Today that has changed to the point where 80¢ of every dollar is spent for people. While hardware was becoming faster, more capable, and less expensive, adequately trained personnel was in relatively short supply and increasingly expensive.

As programming has become relatively more expensive, the burden of providing a program to operate the computers efficiently has been partly shifted to the vendor. The introduction of software such as input-output (I/O) programming to facilitate both file and channel scheduling and number conversion routines made use of more advanced computer capabilities possible with a reduction in individual programming effort by the user. This approach expanded logically into high-level problem-oriented languages such as FORTRAN, ALCOL, COBOL, PL/I, BASIC, and some of the more specialized languages such as LISP, SNOBOL, and GPSS.

The result is that users can address larger problems, and make use of more sophisticated and complex equipment without having to spend endless hours in trying to master the complexities of the equipment currently installed. Instead their time can be spent in dealing with the substantive data problem to be solved. Even the operational problems such as job scheduling and facilities allocation have been removed to a large extent from the concern of the user and transferred to the computer facility provided by the vendor.

In many cases vendors have succeeded in substituting cheaper, faster hardware for previously software-supported capabilities, making the combined hardware-software package more efficient. For example, binary-decimal conversion routines have been replaced by conversion hardware, and multiple interrupt systems reduce the amount of programming required in an I/O program. The interaction of software and hardware has become so great that the distinction between the two has become quite blurred. Perhaps the time has arrived to start thinking in terms of a "computer facility."

Helping to eliminate the difference between software and hardware has been the introduction of micro-logic or micro programming. This is a technique which promises to make available specially designed capabilities to the user which perform at hardware speeds, but do not require the very expensive developmental and production costs involved if the vendor were to design and build a special purpose computer in the more conventional sense of physical construction.

The decreasing cost of computer capacity combined with the increased ease of use created by problem-oriented languages and vendor-provided program packages have combined to make computing facilities more economically accessible to a wide range of users and uses. Applications need no longer be limited to just the high-volume repetitive operations. Now, one-time programs useful in special management analyses are not only sufficiently inexpensive to produce, but also can be completed promptly enough to be useful. Small firms can now profitably enjoy the benefits of using computer resources to handle information processing requirements which were previously too small to justify past computer systems.

No one seriously questions the continued importance of the computer industry or the real opportunities it presents for exciting, rewarding careers. But a change in emphasis is occurring which should be understood by those in and entering the field. There will always be a demand for the highly-specialized "machine"-oriented programmer and technician. Development of new operating systems, compilers, and other programming systems is an essential ingredient in the effort which makes computers useful. But this individual fits into a very specialized slot and represents a decreasing proportion of the total personnel devoted to making computer facilities productive and profitable. Of great importance today is the individual who has the broader understanding of what the computer facility is, what its capabilities and limitations are, and how to apply this facility to the best solution of the organization's information processing needs.

Sheer technical virtuosity is no longer so significant when the user can communicate directly with the computer through a problem-oriented language. On the other hand, sound analytical judgment of capability and related costs and benefits is of primary importance when the major proportion of a firm's operating data and procedures is dependent upon the success of an important information system. And as computers become bigger, faster, and have more data collection and communication ability the information system. And as computers become greater significance in the success (or failure) of the firm's activities.

Computer technology has already changed much of the pattern of life. Hotel and airline reservations are confirmed instantly. Bank deposits and checking accounts are processed automatically. The computer has served as a successful, patient, and effective teacher. It has been possible to simulate activities and test alternate solutions before committing physical resources to one course of action. Vast data networks make great libraries of information available to geographically scattered users whether they be divisions of a private firm, governmental agencies, or just students seeking access to an inter-library loan. There is almost unlimited potential for benefits from this new technology.

Yet, as with any great technological innovation, there are potential dangers. Reckless introductions of poorly planned applications can be expensive and actually disrupt the activity they were intended to facilitate. The ability which now exists to collect and organize vast quantities of data about any organization or individual carries with it the very serious obligation to exercise due care for the accuracy and integrity of the data. One serious concern is the threat of loss of privacy posed by the existence of technical ability without adequate legal safeguards to control its use.

The development of more complex equipment and advanced techniques has led to increasingly sophisticated and widespread applications of computers. This carries with it an obligation to provide intelligent direction and adequate control so as to gain the maximum benefits possible. The future promises faster, cheaper, bigger computers. How computers are used, and the benefits derived from them, depends entirely on human wisdom.